



Course Unit: 2014004 – Embedded Systems

Year 1 Semester 1 ISCED Code: 0714 ECTS: 7,5

Type of Course Unit: Compulsory Delivery Mode: Face-to-face / Distance Learning Language of Instruction: Portuguese

COURSE COORDINATOR: João Carlos Martins

HOURS OF WORK

TOTAL HOURS	Contact Hours								Hours in autonomous work
	Theory	Theory and practice	Practical and laboratory work	Field work	Seminar	Internship	Tutorial guidance	Other	
187,5		45							142,5

Prerequisites (if applicable): n.a.

LEARNING OUTCOMES (knowledge, skills and competence)

On successful completion of this course unit, the student should be able to:

1. Understand the importance of the embedded systems in the IoT.
2. Analyze and elicit the requirements of an embedded system.
3. Know the main computer systems used in IoT for embedded systems.
4. Use the different modules that make up an embedded system for IoT.
5. Apply a computer system in development of an IoT embedded system.
6. Acquire signals from sensors in a IoT embedded system.
7. Know how to use the principal types of sensors found in a IoT system.
8. Characterize the main specifications and attributes of real-time operating system.
9. Specify an embedded system for a particular IoT application.
10. Build an embedded system for IoT.
11. Summarize in the form of a report the steps needed to implement an embedded system for an IoT application.

CONTENTS

1. Introduction to the embedded systems for IoT.
2. Specification and design of an embedded system.
3. Types of microcontroller families.
4. Microcontroller system of outputs / inputs.
5. Interrupt system in a microcontroller.
6. Clocks and timers.
7. Interfacing with displays, sensors and actuators.
8. Serial communications: UART, SPI, I2C, USB.
9. Data acquisition and communication (ADC converters).
10. Introduction to real-time operating systems.

DEMONSTRATION OF THE CONTENTS COHERENCE WITH THE COURSE UNIT'S LEARNING OUTCOMES

We specify the relevant contents for each learning outcome:

1. Understand the importance of the embedded systems in the IoT. (1)
2. Analyze the requirements of an embedded system. (1, 2)
3. Know the main computer systems used in IoT for embedded systems. (1, 3)
4. Use the different modules that make up an embedded system for IoT. (3, 4, 5, 6, 7, 8, 9)
5. Apply a computer system in development of an IoT embedded system. (2, 3)
6. Acquire signals from sensors in a IoT embedded system.(7, 8 ,9)
7. Know how to use the principal types of sensors found in a IoT system. (7, 9)
8. Characterize the main specifications and attributes of real-time operating system. (10)
9. Specify an embedded system for a particular IoT application. (2, 3, 4, 5, 6, 7, 8, 9)
10. Build an embedded system for IoT. (4, 5, 6, 7, 8, 9)
11. Summarize in the form of a report the steps needed to implement an embedded system for a IoT application. (all contents).

TEACHING METHODOLOGIES

Each item of the syllabus will be presented orally with discussion with all class. To specify and design an embedded system will follow the standard recommended by the document IEEE Standard 830. After the introduction of each topics from 3 to 8 there will be a practical work using a low-cost computer system (MSP430 or ARM Cortex-M4) in which the specific module under study will be programmed and used. The practical work in each laboratory will be incremental, ie, each new work brings together the new knowledge is added to the acquired previous content, increasing the system complexity to be developed. At the end, students must design and implement, in groups of 2 or 3 students, an embedded system prototype for an IoT application.

DEMONSTRATION OF THE COHERENCE BETWEEN THE TEACHING METHODOLOGIES AND THE LEARNING OUTCOMES

The students should know the main computer systems used in the development of embedded systems for IoT. The students start by doing a survey of the most common platforms and make a discussion of its features with the rest of the class. After a generic characterization of these computer systems (microcontroller/microprocessor), a particular system will be used to demonstrate its various constituent subsystems, and examples of its use and programming will be discussed.

In the practical part of this course, the students will have to implement several applications, using each of the subsystems, with an increasing complexity, culminating in a final project which aims to develop a system that solves a specific problem, by using an integrated microcontroller/microprocessor in the area of IoT.

EVALUATION METHODS

The evaluation will have three components:

1. Practical laboratories. (40%)
2. Analysis of an IoT system (10%)
3. Design and development of an embedded system for IoT, with presentation and discussion of the project report. (50%)

MAIN BIBLIOGRAPHY

- Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley, 2014.
- Manuel Jiménez and Rogelio Palomera, Introduction to Embedded Systems: Using Microcontrollers and the MSP430, Springer, 2013.
- Jonathan W. Valvano, Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2013.
- Jerry Luecke, Analog and Digital Circuits for Electronic Control System Applications: Using the TI MSP430 Microcontroller, Elsevier, 2005.
- Stuart Ball, Analog Interfacing to Embedded Microprocessor Systems, Newnes, 2003.
- Paul Scherz, Simon Monk, Practical Electronics for Inventors, 4th edition, McGraw-Hill Education, 2016.

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